Space Weather Technical Forecast

Issued on Thursday, 25 January 2024 at 12:53 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: CME arrivals possible later 25 January into early 26 January, with G1 storms likely and a chance of G2 storms. Moderate solar activity likely.
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with one M-flare, M1.3 observed at 24/2058 UTC, from AR3561. There are currently six sunspots on the visible disc. AR3561 and AR3559 are the two largest and most complex regions. AR3561 in the southwest is displaying some minor decay in areal extent recently, although this could be due to its increasing proximity to the limb, which is starting to make assessing the magnetic structure more difficult. AR3559 in the northwest has a large delta region, perhaps breaking apart, and appears to be slowly losing area. AR3555 is situated very close to AR3561 which makes it difficult to determine the separation, and these could be considered one region. The remaining spot regions are small and simple at present.
There have been several CMEs emerge in the last 24 hours, none of which are thought likely to be Earth directed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR, showed waning weak fast winds, followed by a weak CME arrival around 25/0537 UTC. Wind speeds were mostly at slightly elevated levels, between 380-460 km/s. Density has been mostly near or below average. Total magnetic field strength has been weak at 7nT or below. Bz has varied mostly weakly between +/- 7nT, especially after the CME arrival. Phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet throughout (Kp 0-1).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at background levels.
GOES16 high energy (greater than 2MeV) electron flux was at background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a steady trend. At 25/0000UTC the 24-hour integrated fluence observation was 1.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Activity has declined over the last day or so, but is expected to be Low to Moderate with a chance of further isolated M-flares and a slight chance of an X-flare.

Solar Wind / Geomagnetic Activity: There is potential for at least three CME glancing blows in the coming days. In addition, these CMEs are all expected at a similar time - from later on Day 1 (25 Jan) to early on Day 2 (26 Jan), with the potential for them to either combine or arrive one after the other, perhaps increasing any geomagnetic effects.
Overall, geomagnetic activity is expected to be mostly Quiet to Unsettled initially, with an increase expected later Day 1 into Day 2, perhaps step-wise if the various CMEs arrive separately, with Active to G1/Minor Storms likely and a chance of G2/Moderate Storms. There is a slight chance of G3/Strong Storms, should the CMEs combine favourably for this to occur. Geomagnetic activity should then gradually return to Quiet levels by Day 4 (28 Jan) after any residual CME effects have waned.

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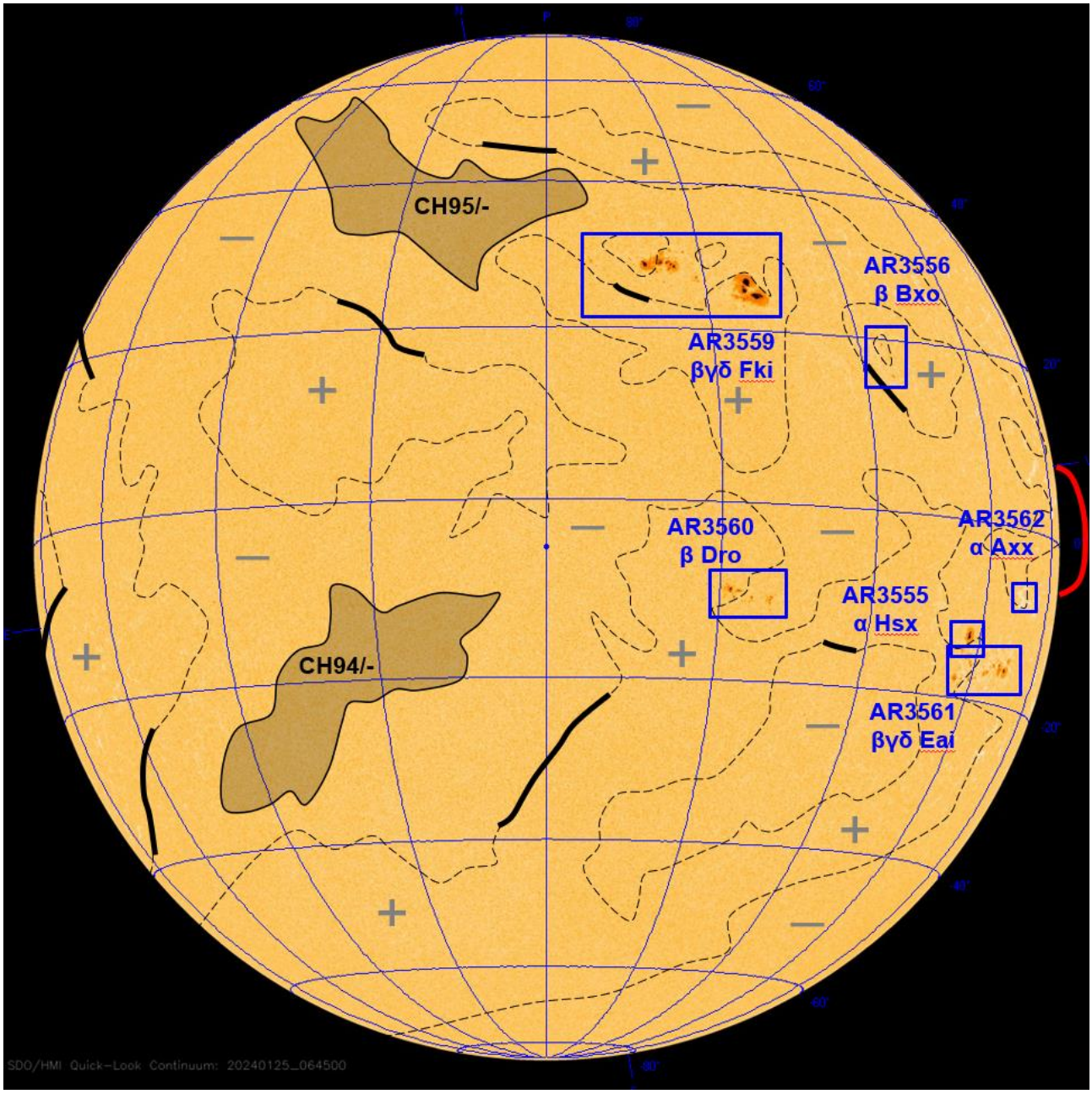
Energetic Particles / Solar Radiation: There is a slight chance of radiation storms throughout, due to both AR3559 and AR3561.
The high energy electron (greater than 2MeV) flux is uncertain due to the effects of multiple possible CME arrivals on the forecast, but may rise later in the period. There is a slight chance of electron fluence exceeding Active (1e8 integrated pfu) Days 3 and 4 (27-28 Jan), but with significant uncertainty.

Figure 1. Solar Analysis Valid 25/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:
There have been numerous CMEs seen in coronagraph imagery in recent days. The majority of these have been either northward or southward directed, but there is potential for several glancing blows in the forecast period. Of these, there are two CMEs which emerged on 22 and 23 January which are mostly directed below Earth's orbit, but are likely to give some impact at Earth. A third, also seen on 23 January, has the material of the CME directed well to the north of Earth, but a wider shock signature was visible in coronagraph imagery and this may also give a glancing blow.

In addition, these CMEs are all expected at a similar time - from later on Day 1 (25 Jan) to early on Day 2 (26 Jan), with the potential for them to either combine or arrive one after the other, perhaps increasing any geomagnetic effects.

A weak equatorial coronal hole has been identified in the western hemisphere of the disc, which may be the cause of recent slightly elevated wind speeds, but this has been easing and no significant impact is expected from this feature.

Overall, geomagnetic activity is expected to be mostly Quiet to Unsettled initially, with an increase expected later Day 1 into Day 2, perhaps step-wise if the various CMEs arrive separately, with Active to G1/Minor Storms likely and a chance of G2/Moderate Storms. There is a slight chance of G3/Strong Storms, should the CMEs combine favourably for this to occur. Geomagnetic activity should then gradually return to Quiet levels by day 4 (28 Jan) after any residual CME effects have waned.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	70	20	1
Strong	G3	No	5	15	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/1559	Partial	Filament	South-centre disc	620 km/s	25/2100 UTC	Glancing blow
23/0700	Partial	AR3559	Northeast	840 km/s	26/0000 UTC	Mostly shock
23/1230	Partial	AR3561	Southwest	650 km/s	26/0600 UTC	Glancing blow

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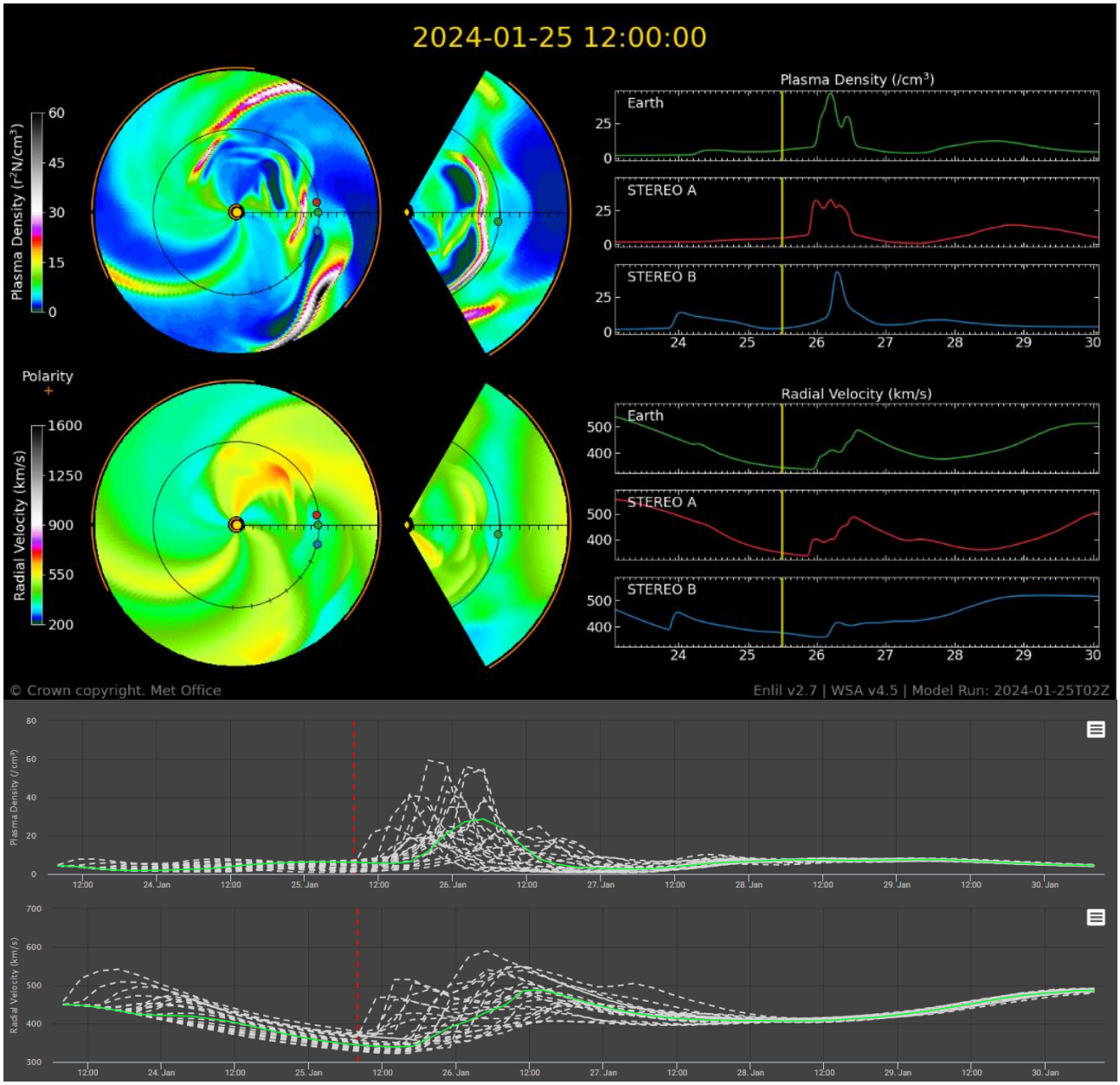
Figure 2: MOSWOC Enlil and ensemble, showing the most likely arrival times of CMEs from later 25 January to early 26 January.



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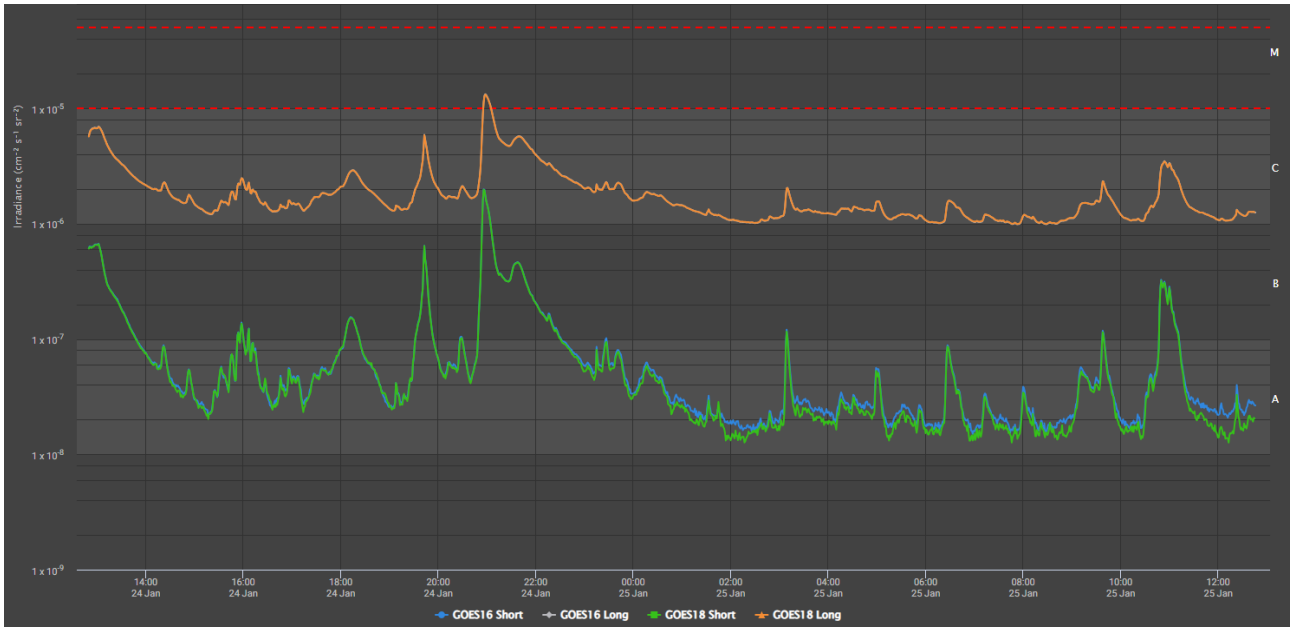
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate with one M-flare, M1.3 observed at 24/2058 UTC, from AR3561.

There are currently six sunspots on the visible disc. AR3561 (Eai/Beta-Gamma-Delta) and AR3559 (Fki/Beta-Gamma-Delta) are the two largest and most complex regions. AR3561 in the southwest is displaying some minor decay in areal extent recently, although this could be due to its increasing proximity to the limb, which is starting to make assessing the magnetic structure more difficult. AR3559 in the northwest has a large delta region, perhaps slowly breaking apart, but appears to be slowly losing area. AR3555 is situated very close to AR3561 which makes it difficult to determine the separation, and these could be considered one region. The remaining spot regions are small and simple at present.

Activity has declined over the last day or so, but is expected to be Low to Moderate with a chance of further isolated M-flares and a slight chance of an X-flare.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	50	50	50	50
Very Active	**R3 to R5 X Class**	No	10	10	10	10

Figure 3: GOES16 and 18 X-ray flares, showing just the one M-flare in the last 24 hours.



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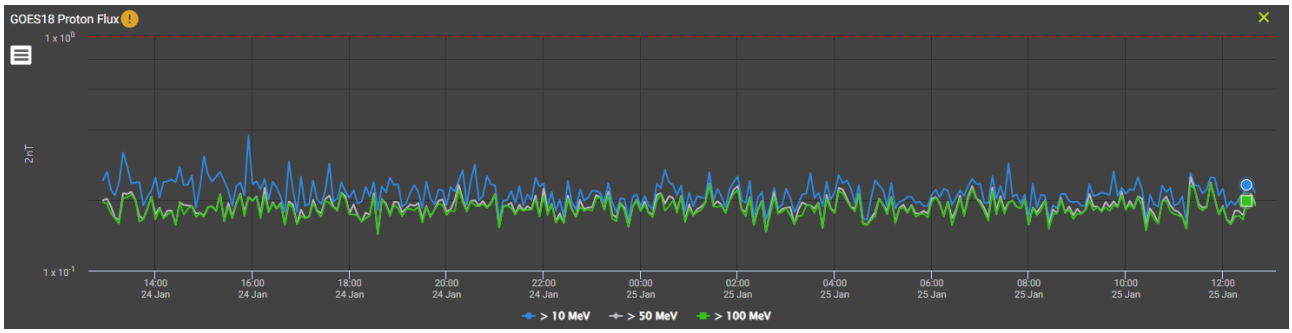
Solar Radiation Storms - (High Energy Protons):
GOES18 high energy (greater than 10MeV) proton flux is at background levels.
There is a slight chance of radiation storms throughout due to both AR3559 and AR3561 being located in the western hemisphere. Both of these regions are magnetically complex, with a risk of an increase in proton flux should they produce any larger flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Proton flux at GOES18 is at background levels.



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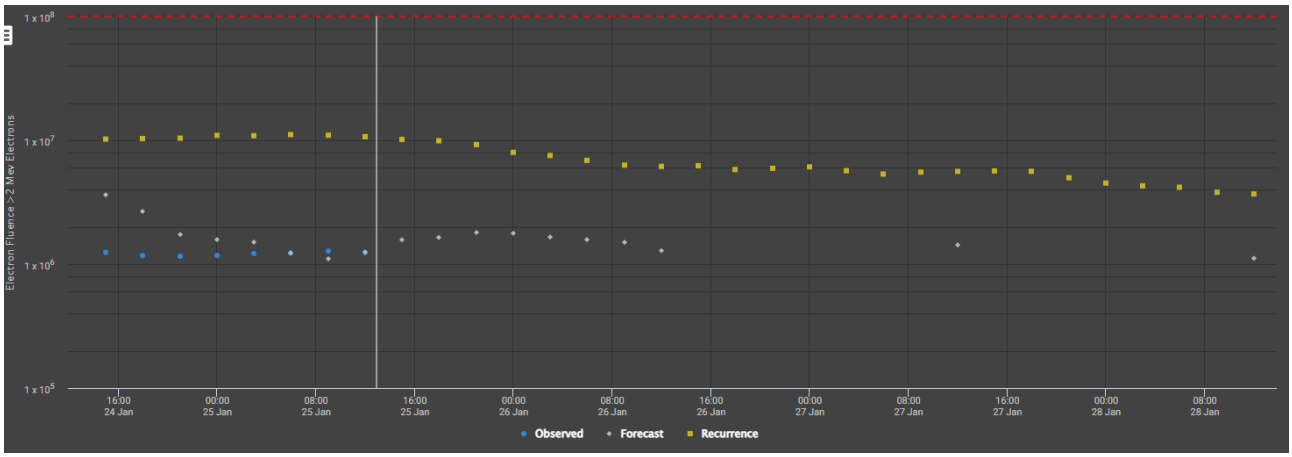
High Energy Electrons Event (≥ 2MeV):
The high energy electron (greater than 2MeV) flux is uncertain due to the effects of multiple possible CME glancing blows on the forecast, but will most likely remain at background levels for much of this period. Towards the end of the period, as CME effects are starting to wane, then electron flux may start to rise. This will be especially true if the CME arrival(s) give stronger geomagnetic activity. However, this is also assuming no further Earth directed CMEs emerge, and at present further CMEs are considered a possibility.

Electron fluence is likely to stay below Active (1e8 integrated pfu) for much of this period, but there is potential for a rise later in the period. REFM is currently providing a good steer for the next day or so, though will not be taking into account any potential CME impact, and is likely to become increasingly unreliable later in the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM, which won't be taking into account the effect of any CME arrivals.



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